County-Level Income Inequality and Depression among Older Americans

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Objectives. To examine (1) whether county-level income inequality is associated with depression among Americans aged 70 and older, taking into consideration county-level mean household income and individual-level socioeconomic status (SES), demographic characteristics, and physical health, and (2) whether income inequality effects are stronger among people with lower SES and physical health.

Data Sources. The individual-level data from the first wave of the Assets and Health Dynamics among the Oldest Old survey (1993–1994) were linked with the county-level income inequality and mean household income data from the 1990 Census.

Study Design. Multilevel analysis was conducted to examine the association between income inequality (the Gini coefficient) and depression.

Principal Findings. Income inequality was significantly associated with depression among older Americans. Those living in counties with higher income inequality were more depressed, independent of their demographic characteristics, SES, and physical health. The association was stronger among those with more illnesses.

Conclusions. While previous empirical research on income inequality and physical health is equivocal, evidence for income inequality effects on mental health seems to be strong.

Key Words. Income inequality, depression, elderly, socioeconomic status, multilevel analysis

Researchers have consistently demonstrated a strong association between socioeconomic status (SES) and health at the individual level (Robert 1998; Smith 1998). What is new is an increasing interest in how socioeconomic conditions of the area of residence influence individuals' lives and health (House 2002; Robert 1998, 1999; Smith 1999). In particular, the relative income hypothesis (Wilkinson 1992, 1996) has stimulated a number of empirical and theoretical papers that attempt to support or question its tenet that the relative SES position, in addition to the absolute level of income, affects health. To refute or confirm the ecological studies that found associations between income inequality, or distribution of individual income, and population mortality across countries (Rodgers 1979; Wilkinson 1992, 1996) and within the United States (Kaplan et al. 1996; Kennedy, Kawachi,

and Prothrow-Stith 1996; Lynch et al. 1998), researchers have attempted to test whether the degree of income inequality in the area of residence affects individuals' health independent of their income and demographic characteristics—the so called "income inequality hypothesis" (Wagstaff and van Doorslaer 2000). The majority of such studies were conducted using data on the United States (Blakely, Kennedy, and Kawachi 2001; Blakely, Lochner, and Kawachi 2002; Daly et al. 1998; Diez-Roux, Link, and Northridge 2000; Fiscella and Franks 1997, 2000; Kahn et al. 2000; Kennedy et al. 1998; Lochner et al. 2001; Soobader and LeClere 1999; Subramanian, Kawachi, and Kennedy 2001), and have provided limited support for the hypothesis. Further empirical studies as well as theoretical work is needed to make sense of inconsistent research findings and to figure out whether the strengths, nature, and underlying mechanisms of income inequality on health depend on dimensions of health, units of geographical aggregation (e.g., country, state, or community), and the population of focus. At this point, little is known about how income inequality in areas smaller than states is associated with mental health. Relative lack of attention to the psychological dimension of health is somewhat surprising, given that researchers often assume that income inequality exerts noxious psychological effects that lead to ill health (Kawachi and Kennedy 1999). Furthermore, older adults have been one of the least studied populations in this area even though older adults and children are considered to be more vulnerable to the environment where they live than younger adults (La Gory and Fitzpatrick 1992).

To fill this gap of research, this article examines the association between county-level income inequality and depression among a nationally representative sample of Americans aged 70 and older, using the first wave of the Assets and Health Dynamics among the Oldest Old (AHEAD) survey linked with county-level decennial Census data of 1990. Depression is a superb indicator of older adults' well being (Mills and Henretta 2001; Mirowsky 1996). The main research questions are: Is county-level income inequality significantly associated with older adults' depression, controlling for county-level mean household income and individual-level demographic characteristics, SES (education, income and wealth), and physical health? And is the effect stronger among individuals with lower levels of SES and physical health?

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BACKGROUND

Previous Research on Income Inequality and Individuals' Health

Most of the U.S. studies involving both area- and individual-level data examine income inequality effects on mortality (Daly et al. 1998; Lochner et al. 2001) or self-rated health (Blakely, Kennedy, and Kawachi 2001; Blakely, Lochner, and Kawachi 2002; Kennedy et al. 1998; Soobader and LeClere 1999). The individual-level data used in these studies are based on large nationally representative samples, such as National Health Interview Surveys and Current Population Studies. For calculation of income inequality, most studies used states as the aggregate level. Only a few studies used smaller geographic units, such as primary sampling units (PSUs) (Fiscella and Franks 1997, 2000), metropolitan areas (Blakely, Lochner, and Kawachi 2002), counties (Blakely, Lochner, and Kawachi 2002; Soobader and LeClere 1999), and census tracts (Soobader and LeClere 1999).

These studies provide mixed results regarding income inequality effects on health, while confirming consistent effects of individual or family income on individuals' health. At this point, evidence for income inequality effects on mortality is limited at best (Daly et al. 1998; Fiscella and Franks 1997; Lochner et al. 2001; Mellor and Milyo 2003). There is some evidence for the association between state-level income inequality and self-rated health (Blakely, Kennedy, and Kawachi 2001; Blakely, Lochner, and Kawachi 2002; Kahn et al. 2000; Kennedy et al. 1998). However, studies that examine income inequality effects on self-rated health at a lower level of aggregation provide mixed results (Blakely, Lochner, and Kawachi 2002; Fiscella and Franks 2000; Soobader and LeClere 1999).

Only a few looked at other dimensions of health, such as depression (Fiscella and Franks 2000; Kahn et al. 2000), biomedical morbidity (Fiscella and Franks 2000), and cardiovascular disease risk factors such as body mass index, hypertension, and sedentarism. Kahn et al. (2000) found statistically significant association between state-level income inequality and depression among mothers with young children. Fiscella and Franks (2000) found a significant relation of PSU-level income inequality with depression, but not biomedical morbidity in a national probability sample of noninstitutionalized adults aged 25 to 74 years. Diez-Roux et al. (2000) provided evidence that state inequality was associated with cardiovascular disease risk factors among a probability sample of noninstitutionalized adults. Based on the above results, income inequality effects seem to be stronger for the psychological dimension

of health, and weaker for the physical dimension, such as biomedical morbidity and mortality.

It has been argued that older adults, especially those with declining health and functions, are more vulnerable to economic and social contexts of the area of residence than younger adults because they are less competent in adjusting themselves to the environment and more dependent on resources available in the area of residence (La Gory and Fitzpatrick 1992; Lawton and Nashemow 1973; Robert and Li 2001). However, existing empirical research findings have provided either contradictory or limited supports for the significance of area contextual effects on older adults' health. For example, studies on the association between income inequality and mortality at state and metropolitan area levels indicated that the correlation was significant among infants and middle age groups up to age 64, but not among older adults (Kaplan et al. 1996; Lynch et al. 1998). Robert and Li (2001) showed that the association between socioeconomic conditions of neighborhoods (census tracts) and individual-level health (self-rated health and the number of chronic diseases) was stronger among older adults than younger adults, but that the association became weak again at ages 70 and older.

Depression in Later Life

Depression covers a wide range of psychological symptoms such as feeling sad, helpless, or demoralized, the presentation of which varies across individuals (McDowell and Newell 1996). Approximately 15 percent of community-dwelling older adults, with a range from 10 percent to 25 percent, suffer from clinically significant depressive symptoms, and the prevalence rates vary across geographical areas (Blazer 2002). For example, epidemiological studies on older adults conducted in Bronx, New York, and rural Iowa reported very different prevalence rates using the same depression instrument: 17 percent and 9 percent (Kennedy et al. 1989; O'Hara, Kohout, and Wallace 1985). Previous research has advanced our knowledge on how individual-level biological, psychological, and social factors are related to depression. For example, researchers have consistently indicated people with lower SES (e.g., lower education and economic hardship) have higher levels of depression (Miech and Shanahan 2000; Mirowsky and Ross 2001) and that social resources (e.g., social support) reduce levels of depression, either directly or indirectly by buffering the effects of stress (Krause 1986). On the other hand, research on area variations in depression is scant. At the neighborhood (census tract) level, evidence suggests that the area contexts

(satisfaction with the environment, neighborhood transportation problems, and poverty) are important determinants of depression among older adults (La Gory and Fitzpatrick 1992). However, we know little about why levels of depression vary across geographic areas larger than neighborhoods in the United States.

Research Questions and Hypotheses

In summary, previous studies on income inequality and health have at least five limitations. First, they pay relatively little attention to the psychological dimension of health. Second, few have focused on older populations. Third, few studies have used geographic units smaller than states, although one's life space is likely to be smaller. Fourth, in assessing individual SES, few studies have taken into account multiple dimensions of individual SES. Current income is an inadequate indicator of SES, especially among older adults who are subject to lifetime accumulation of wealth. It is more appropriate to capture SES using multiple indicators including income, wealth, and education (Robert and House 1996). Fifth, while an increasing number of studies have combined area-level and individual-level data, only a few of them investigated how individual characteristics moderate income inequality effects on health using multilevel models that explicitly account for clustering of individuals in the area (Blakely, Lochner, and Kawachi 2002; Diez-Roux, Link, and Northridge 2000; Subramanian, Kawachi, and Kennedy 2001).

In contrast, this article examines income inequality and depression, a psychological dimension of health, in the oldest old in a multilevel framework. To capture income inequality I used counties as the geographic unit of aggregation. As people age and develop health problems, their local residential areas become primary social contexts and sources of social support. Social interactions with relatives, friends, and neighbors and informal social support provisions tend to occur in the home and neighborhoods, whereas sources of formal support such as health, social, and governmental services span larger areas. In most parts of the country, counties are geopolitical units that are the bases of local government services and are often used by health and social service organizations to plan and provide services for elders. Thus counties often constitute contexts for older adults to receive formal services and interact with service providers. To measure individual-level SES, this study used education and multiple alternative measures of income and wealth to capture their nonlinear relationships with

health. As in past research, I assumed individuals' demographic and socioeconomic characteristics partly determine depression in older adults.

The central hypothesis of this research is that a higher level of income inequality is associated with higher levels of depression, controlling for various individual factors and county-level mean household income. Income inequality is a snapshot of the distribution of household incomes in the geographically defined area and reflects complex social processes, including unequal opportunities for education and employment in earlier life, and residential economic segregation. Income inequality may lead to depression in at least two ways. First, elderly persons interact with, or are exposed to, persons who vary greatly in income and social class on various occasions such as when they seek medical, social, and governmental services and information, either in person, by telephone, or through the media. These interactions make individuals aware of their relative standings in the society. Such awareness may produce negative emotions such as distrust and shame in elders, reduce cohesiveness, and increase conflicts in the social environment, and thus create chronic stress in everyday life (Kawachi and Kennedy 1999). To make matters worse, less-cohesive society offers less social support and other resources that may buffer the effects of stress on mental health, because it is harder to find others of the same values and develop informal social ties. Second, income inequality may affect older adults indirectly through its impact on those who work in health, social service, and governmental organizations with which older adults tend to have frequent contacts. People who commute to those organizations from the surrounding area have diverse socioeconomic and professional statuses, ranging from specialty physicians and executives to nurse aides and receptionists. To the extent that income inequality in the area negatively affects informal social relationships as mentioned above, it may also permeate and distress formal work relationships, hampering coordination and collaboration among service providers that are essential to meet the complex medical and social needs of older adults. Having to obtain information and services from such organizations frequently may be a stressful and depressing experience for older adults.

The study's secondary hypothesis is that noxious effects of income inequality are stronger for individuals with lower levels of SES and physical health, net of other variables in the model. The environment becomes even more stressful when older persons become ill or disabled and more dependent on health and social services, while having less energy and capacities to deal with stressful environments. Those with low SES lack economic resources (income and wealth) and personal resources that may be obtained through

education (skills, knowledge and personal networks with people in power) that buffer the impact of income inequality. In addition, the feelings of shame and distrust in society may be stronger among the poor.

METHODS

Sample and Data

The individual-level data came from the public use data files of the first wave of the AHEAD survey, conducted from October 1993 to July 1994. The survey examined the impacts and interrelationships of changes and transitions for older Americans in three domains: health, financial, and family. Complete information on the survey can be found on line (http://hrsonline.isr.umich.edu/meta/1993/core/desc/and93dd.pdf). My analysis is restricted to a sample of 6,640 respondents, taken from the total sample of 7,447 noninstitutionalized individuals aged 70 and older. Of the 807 respondents who were dropped from the analysis, 786 had proxy respondents mainly because of physical or cognitive problems, 2 had missing values in depression, and 19 had incomplete geographic information. Questions on depression require the respondent to evaluate his or her own state of mind and thus were not asked of proxy respondents. To the extent that health problems increase depression and make people more vulnerable to their environment, the results from this study may underestimate the level of depression and the interaction effects of physical health and income inequality.

A restricted data file containing county identifiers permitted us to link county-level data on income inequality and mean household income to the micro data.[1] The data include 211 counties. The number of individuals in each county ranges from 1 to 182, with the mean value of 31.5 and standard deviation of 36.0. County-level income inequality and mean household income calculated from the 1990 Census were purchased from the Bureau of Census (U.S. Census Bureau 1990). The sample characteristics are presented in Table 1.

Measures

The dependent variable, depression, was measured by a scale using the eight items included in the AHEAD that are based on the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is one of the most commonly used self-rating scales of depression (McDowell and Newell 1996). Most surveys of community, clinical, and institutional populations use self-rating scales partly because of poor interrater reliability of clinician-based diagnoses of depression and partly because of the cost associated with gathering clinical

Table 1. Descriptive Sample Characteristics: AHEAD Wave I (1993–1994) Respondents Born in 1923 or Earlier ($N = 6{,}640$) and Their Counties of Residence ($N = 211$)

Variables	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
County-level (n = 211)				
Income inequality (Gini)	0.42	0.04	0.30	0.59
Mean household income (in thousands of dollars)	40.47	10.64	22.78	70.92
Individual-level (n = 6,640)				
Depression*	1.68	1.99	0	8
Age at interview (years)	77.31	5.66	69	103
Gender (female = 1)	.62	.49	0	1
Marital status (currently married = 1)	.48	.50	0	1
Family income (in thousands of dollars)	22.29	28.63	0	700
Family net assets (in thousands of dollars)	183.31	397.89	− 106	14655
Ethnic groups				
Black-non-Hispanic	.13	.34	0	1
Hispanic	.05	.22	0	1
White-non-Hispanic and others	.82	.39	0	1
Education (years of schooling)	10.92	3.69	0	17
ADL limitations	.56	1.15	0	6
IADL limitations	.42	.86	0	5
Number of illnesses	2.05	1.47	0	9

*Depression is measured by an eight-item abbreviated CES-D scale, which ranges from 0 (not depressed at all) to 8 (maximum level of depression).

diagnostic information (Blazer 2002). The original CES-D is a 20-item, self-report depression scale originally developed to identify depression in the general population (Radloff 1977), using a 0-to-3 response scale. The AHEAD uses eight items that represent depressed mood and somatic complaints, using a 0–1 response scale. Respondents were asked to rate whether they experienced the following feelings much of the time during the past week (yes or no): (1) I felt depressed, (2) I felt that everything I did was an effort, (3) My sleep was restless, (4) I was happy, (5) I felt lonely, (6) I enjoyed life, (7) I felt sad, and (8) I could not "get going." The composite scale was created by summing those eight items with the reversed codes of positive items so that higher values indicate more depressed. Psychometric evaluations of this eight-item CES-D scale supported the validity of this instrument, showed good reliability or internal consistency (.78), and resulted in low missing items/nonresponses (Mills and Henretta 2001; Steffick 2000).

County-level measures of income inequality, measured in the Gini coefficient, and average household income calculated from 1990 census data

were purchased from the Census Bureau. The Gini coefficient is derived from the Lorenz curve, which graphically represents the cumulative share of the total income accrued to successive income intervals (Kawachi and Kennedy 1997). It is the most commonly used measure of distribution of household income (Blakely, Lochner, and Kawachi 2002), ranging from zero (absolute equality) to 1.0 (absolute inequality) (Cowell 1977; Kawachi and Kennedy 1997).

Individual-level variables include age, gender, socioeconomic, and marital status, race/ethnicity (black-non-Hispanic, Hispanic, and white-non-Hispanic and others), and physical health. Physical health was measured by three self-reported variables: number of illnesses, number of limitations in activities of daily living (ADL), and instrumental activities of daily living (IADL). Socioeconomic status was represented by education (years of schooling), family income, and family net assets. The respondent was asked to report annual total family income (income of the respondent and spouse, if present) from all sources before taxes, which includes social security income, regular income (retirement pensions, veteran's benefits, annuities, payments from an individual retirement account), food stamps, investment income, and financial (cash) assistance from relatives. Wealth (net assets) of the respondent and spouse or partner was assessed by adding assets from 12 sources (including savings, home and land, own business, and investments) and negative assets or debts. To control for the number of people who share income and assets, the model includes marital status (coded 1, if currently married and spouse present, 0 otherwise). I used two alternative measures of income and assets that allow modeling nonlinear relationships with depression. First, I created two dummy variables representing three categories (high, middle, low) of income groups, based on the tercile points for income and wealth, respectively. This measure allowed me to examine whether the effect of being in the reference category (lowest income/wealth category) differs significantly from the effects of being in the other two categories. Second, a piecewise linear spline function was used. This allows estimation of different slopes over the three income/wealth groups: high, middle, and low (Smith and Kington 1997).[2] I centered all the continuous variables to make the intercepts of the models interpretable (Raudenbush and Bryk 2002). The correlations among SES variables were relatively high, but all below 0.43.

Analytic Strategies

I conducted a multilevel (two-level) OLS regression analysis[3] using *HLM5* software (Raudenbush et al. 2000). Multilevel models, which have seen

significant development in the past decade, are a set of related analytic approaches for exploring links between macro and micro levels of social phenomena (DiPrete and Forristal 1994). These models, also called contextual models, hierarchical linear models, or random coefficient models, have several advantages. First, they deal with the nonindependence of observations engendered by the nesting of subjects within county. Second, they provide a useful means of linking macro-level data to individual outcomes. Finally, they explicitly recognize the fact that the counties represented in the sample are a subset of the counties to which I wish to generalize.

Previous research on social determinants of health that incorporated area-level variables (e.g., social and economic conditions) without using multilevel models assumes that all the multilevel structure in the data is fully explained by those area-level and individual-level variables. In contrast to such research, this research assumes that there are additional unmeasured effects at the county level. In other words, in addition to the county-level variables (income inequality and mean household income) included in my model, other county-level variables (e.g., weather, urban/rural, political climates, service availability) may explain between-county variation in individual levels of depression. I allow such additional effects by letting the county-specific intercepts of the model vary randomly from county to county. Doing so assumes that the 211 counties in the data are random draws from a population of some 3,100 counties and that the random effects are independent and identically distributed across counties. In other words, it is assumed that the unexplained county effects are governed by mechanisms that are roughly similar from one county to another and operate independently between the counties. This assumption also helps overcome the small number of individuals in some counties by "borrowing strength" to estimate the effects of such counties from those with a large number of individuals (Raudenbush and Bryk 2002; Snijders and Bosker 1999).

The AHEAD survey oversamples African Americans, Mexican-Hispanics, and residents of the state of Florida. The oversamples are controlled largely by race/ethnicity variables, and PSUs vary mainly along race and SES dimensions. My models include race/ethnicity and SES variables, which contain most of the information embedded in the survey design. Thus I report the results based on unweighted data (Winship and Radbill 1994) and use "Huber corrected" standard errors (Raudenbush and Bryk 2002), which are robust against violation of assumptions about nonindependence of observations and heteroskedasticity.

RESULTS

First, I conducted a two-level regression analysis without any independent variables except for the intercept (fully unconditional model) to examine approximately how much of the variation in depression is at the county level as opposed to the individual level. The percentage of variation of depression at the county level (also known as intraclass correlation) was 3.2 percent, which is fairly small but not uncommon for health outcomes. After individual-level variables were entered in the model, this proportion became smaller (1 percent) but remained statistically significant.[4] This county-level variance is the maximum variance explainable by any county-level variables.

Effects of County-Level Income Inequality and Individual-Level SES on Depression

To examine whether county-level income inequality (Gini) is significantly associated with depression, two random-intercept models were estimated (Table 2). Models 1 and 2 are the same except for the measures of income and wealth: Model 1 includes two dummy variables representing three categories of income/wealth, while Model 2 involves a piecewise linear spline function of income/wealth to estimate different slopes over the three income/wealth groups. Both models indicate that income inequality was significantly associated with depression, suggesting that living in a county with higher income inequality increases the level of depression. The county-level variance explained by income inequality was 27 percent, indicating the importance of this variable.[5] Mean household income, on the other hand, was not significantly associated with depression after controlling for all the individual-level variables with or without income inequality in the model. None of the county-level variance was explained by mean household income.

At the individual-level, as consistent with previous research, being older, female, and unmarried, and having more illnesses and ADL/IADL limitations were associated with higher levels of depression. People with higher SES were significantly less depressed than those with lower SES, but the income effects were not statistically significant. This reiterates the importance of including wealth and education as measures of SES. The effects of wealth on depression were clearly nonlinear. In other words, the association between wealth effects was stronger in lower wealth groups. Specifically, Model 1 indicates that people in the higher wealth groups had significantly lower levels of depression than those in the lower groups. Model 2 demonstrates that the wealth effects become smaller across the wealth groups with the stronger effects among the poor, and the weaker among the affluent. In both models, the estimated

Table 2: Estimated Effects of County-Level and Individual-Level Factors on Depression: Income Inequality Main Effects

	Model 1		*Model 2*	
Fixed Effect	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	1.8748***	0.0855	1.6868***	0.0680
County-Level Variables				
Gini	2.6432***	0.8043	2.5941***	0.8094
Mean income	0.0021	0.0030	0.0021	0.0029
Individual-Level Variables†				
Age	−0.0027	0.0046	−0.0028	0.0045
Female	0.1523***	0.0535	0.1469***	0.0531
Married	−0.3588***	0.0543	−0.3509***	0.0553
Education	−0.0606***	0.0071	−0.0596***	0.0074
Income:				
Groups -Middle	−0.0016	0.0722		
-High	−0.0739	0.0797		
Spline -1st tercile (Low)			−0.0138	0.0145
-2nd tercile (Middle)			0.0004	0.0067
-3rd tercile (High)			0.0003	0.0007
Wealth:				
Groups -Middle	−0.1741***	0.0642		
-High	−0.2089***	0.0698		
Spline -1st tercile (Low)			−0.0039**	0.0020
-2nd tercile (Middle)			−0.0009	0.0007
-3rd tercile (High)			−0.0001***	0.0000
Race/ethnicity:				
Black-non-Hispanic	−0.0999	0.1171	−0.1108	0.0760
Hispanic	0.2984**	0.0772	0.2882**	0.1163
ADL limitations	0.3376***	0.0285	0.3375***	0.0285
IADL limitations	0.1944***	0.0318	0.1934***	0.0319
Number of illnesses	0.2383***	0.0161	0.2374***	0.0161
Random Effect‡	Variance component	χ^2 (d.f.)	Variance component	χ^2 (d.f.)
County mean depression	0.0320***	439.21 (190)	0.031047***	436.15(190)
Individual-level variance	3.1107		3.1094	

***$p \leq 0.01$, **$p \leq 0.05$, *$p \leq 0.10$ (two-tailed tests).

Note: Models 1 and 2 are random intercept models estimated based on the restricted maximum likelihood method, using unweighted data. All the continuous variables were centered to facilitate the interpretation of the intercept. The intercept represents the level of depression when independent variables are constrained at the average value for continuous variables or at the reference category for categorical variables. Depression is measured by an eight-item abbreviated CES-D scale, which ranges from 0 (not depressed at all) to 8 (maximum level of depression). Robust or "Huber-corrected" standard errors are reported.

†Reference categories are male (gender), not currently married (marital status), low (income groups), and low (wealth groups).

‡The variance component of the intercept (county mean depression) represents the county-level residual variance or county effects that are left unexplained by the model, and the variance component of individual-level effects represent the individual-level residual variance.

proportion of individual-level variance explained by the individual-level model was 19 percent.[5]

Stronger Income Inequality Effects on Depression among People with Lower Levels of SES and Physical Health

Next, building on Model 1, I examined whether income inequality effects on depression were stronger among older adults with lower levels of SES and physical health. Results partially supported the hypothesis, indicating that people with more illnesses had significantly higher income inequality effects (Model 3). No significant interactions were found between income inequality and other individual-level SES[6] and physical health variables.

DISCUSSION

This research supported the "income-inequality hypothesis" for mental health, demonstrating significant association between county-level income inequality and depression among older Americans. Inclusion of individual-level variables, in particular, alternative nonlinear specifications of income and wealth as indicators of individual-level SES, strengthened this finding. Multilevel analysis results indicated that income inequality accounted for a significant proportion (27 percent) of the maximum variance explainable by county-level variables. Income inequality effects were stronger among those who had more illnesses. This suggests older adults' physical health buffer the deleterious effects of income inequality on their mental health.

Previous research has shown that depression is associated with income inequality measured at the state level (Kahn et al. 2000) and at the PSU level (Fiscella and Franks 2000) among mothers with young children (Kahn et al. 2000) and among noninstitutionalized adults aged 25 to 74 years (Fiscella and Franks 2000). My research indicated the association at the county level among noninstitutionalized persons ages 70 and older. Taken together, research to date has consistently supported associations between depression and income inequality for a wide range of geographical aggregations and populations. Empirical evidence for income inequality effects is stronger in mental health than in physical health.

My results also corroborate a small but important literature on the significance of environments on older adults' health and well-being. La Gory and Fitzpatrick (1992) found significant effects of environmental characteristics (e.g., socioeconomic conditions, availability of automobile transporta-

Table 3: Estimated Effects of County-Level and Individual-Level Factors on Depression: Cross-Level Interaction between Income Inequality and Number of Illnesses

	Model 3	
Fixed Effect	*Coefficients*	*Standard Error*
Intercept	1.8727***	0.0854
County-Level Variables		
Gini	2.6387***	0.8143
Mean income	0.0021	0.0030
Individual-Level Variables†		
Age	−0.0023***	0.0046
Female	0.1534	0.0534
Married	−0.3556***	0.0544
Education	−0.0602***	0.0071
Income: Groups -Middle	−0.0747	0.0794
-High	−0.0001	0.0720
Wealth: Groups -Middle	−0.2100***	0.0697
-High	−0.1750***	0.0636
Race/ethnicity: Black-non-Hispanic	−0.0992	0.0765
Hispanic	0.2935**	0.1161
ADL limitations	0.3351***	0.0284
IADL limitations	0.1949***	0.0317
Number of illnesses	0.2176***	0.0169
Cross-Level interaction		
Gini*Number of illnesses	1.1721***	0.4001
Random Effect‡	Variance component	χ^2 (d.f.)
Intercept (county mean depression)	0.0327***	285.80 (208)
Individual-level effect	3.1065	

***$p \leq 0.01$, **$p \leq 0.05$, *$p \leq 0.10$. (two-tailed tests)

Note: Models 3 is a random intercept models estimated based on the restricted maximum likelihood method, using unweighted data. All the continuous variables were centered to facilitate the interpretation of the intercept. The intercept represents the level of depression when independent variables are constrained at the average value for continuous variables or at the reference category for categorical variables. Depression is measured by an eight-item abbreviated CES-D scale, which ranges from 0 (not depressed at all) to 8 (maximum level of depression). Robust or "Huber-corrected" standard errors are reported.

†Reference categories are male (gender), not currently married (marital status), low (income groups), and low (wealth groups).

‡The variance component of the intercept (county mean depression) represents the county-level residual variance or county effects that are left unexplained by the model. The variance component of individual-level effects represents the individual-level residual variance. Since the individual-level models are virtually the same in Models 1 and 3 except that the latter involves cross-level interaction term, the level-1 variance estimates were almost identical across these models. Proportion reduction in variance statistics at county-level is interpretable only for the same individual-level model. The cross-level interaction term in Models 3 did not allow calculation of those statistics based on Models 1 and 3.

tion) on depression among older adults, using neighborhoods approximated by census tracts. On the other hand, I used a higher level of geographic aggregation (counties). Elders' zones of informal interaction may vary across individuals and may dwindle as they develop functional limitations. On the other hand, as people become older and develop multiple chronic diseases, they may become more vulnerable to the characteristics of a larger area (e.g., county) where they receive health, social, and governmental services. As the number of illnesses increases, the number of health and social service providers with which the older person interacts multiplies. Health and social service organizations consist of executives and professionals with high SES as well as frontline care providers who tend to have lower SES (e.g., nurse aides, home care workers). To the extent income inequality produces distrust among people and results in poor personal interactions within and across those service organizations, the older person with multiple illnesses is exposed to inefficient organization and coordination of services as well as stressful interactions with those providers.

Health policy researchers are divided regarding the importance of income inequality in health (Mellor and Milyo 2003). My research supported the importance of county-level income inequality in depression among older adults, but differences in depression across counties were quite small compared to individual differences. This was not particularly surprising, partly because individual differences are almost always larger than group differences in any individual-level phenomena (Hauser 1969) and partly because between-individual differences in health are quite large among older adults. Limited empirical support for income inequality effects on physical health and the small variance in health that is explainable by area-level variables would make it difficult for addressing income inequality to become a priority health policy. Moreover, it is difficult to determine what the appropriate geographic unit to focus on should be. The relevant geographic life space differs not only across individuals but also within individuals depending on the dimensions of life in question. Counties, as with any other geographic units, may not always correspond to one's life space. Nonetheless, counties are geopolitical units often used for governmental and social/health services for older adults and thus are reasonable life spaces for the analysis of the elderly population.

This study relied on national probability sample survey data and hence has an inherent limitation: the number of respondents varies across counties. While 20 counties had lone representatives, 20 counties with the largest sample size (10 percent of sampled counties with $n = 92$ to 182) accounted for

36 percent of the sample. Although comparing those top and bottom 20 counties did not indicate apparent differences in terms of Gini, mean income, and location (urban, suburban, and rural), my results are more influenced by counties with larger sample sizes and need to be interpreted with caution. Furthermore, as in previous studies on income inequality and health, this study was cross-sectional. It did not account for the length of individuals' exposure to the area of residence nor measurement errors inherent in individual-level income, wealth, and health. Future studies should involve longitudinal data that will allow us to address measurement errors both in independent and dependent variables. My side analysis indicated that income inequality effects were weaker when I specified individual-level income and wealth more correctly (see Note 2), suggesting that income inequality effects on health at least partly capture individual-level processes. Thus individual-level SES measurement and specification need to be as precise as possible to identify any unique contribution of county-level income inequality.

Despite these limitations, this article's main findings, that county-level income inequality is associated with depression among all elders and particularly those with more illnesses, provide health policy implications, especially in relation to resource allocations. Although virtually all Americans aged 65 and older are covered by Medicare for acute medical care, availability of long-term care and other social services vary across geographic areas (Muramatsu and Campbell 2002). Those services are funded by a variety of sources, including federal (e.g., Older Americans Act money allocated to local governments), state (e.g., Medicaid), county, and municipal governments. Allocation is often based on individuals' income and wealth or average economic conditions of the area. Research findings on income inequality and health suggest that policymakers pay particular attention to poor and ill individuals living in areas with high income inequality. This line of research may also inform mental health professionals who work with older adults to pay attention to potential chronic environmental stresses as well as individual-level stresses. Further theoretical and empirical studies are needed, however, to obtain a better understanding of the relationship between income inequality and health, especially the pathways between income inequality and health that may vary across dimensions of health, populations of focus, and levels of geographic areas.

The distribution of income in the United States has become increasingly unequal since the early 1970s (Morris and Western 1999). The increasing economic gap between the rich and the poor suggests growing health disparities among Americans, especially the elderly, who are subject to

cumulative effects of income gaps. In fact, my research indicated that wealth, not current income, had strong main effects on depression. Whether or not area-level income inequality turns out to be important for elders' physical as well as mental health, it is vital to address the individual needs of older Americans with low SES and multiple illnesses.

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NOTES

1. AHEAD restricted datasets and files include sensitive information, such as respondents' place of residence. In order to protect confidentiality, their availability is limited through restricted release as described on line at http://hrsonline.isr.umich.edu/rda/.
2. I also estimated the models with two additional cruder measures of income and wealth: (1) a simple sum of total income and wealth in thousands of dollars, which assumes a linear relationship with depression, and (2) the natural logarithms of (1). The income inequality effects in the model with (1) are larger than the ones with (2), which are larger than the models reported in Table 2 with more "sophisticated" measures to allow nonlinear relationships. These results are consistent with the argument that income inequality effects on health reported in previous studies at least partly capture individual-level nonlinear relationships between income and health, as most previous studies do not control for individual-level income at all or do not fully take into account non-linear relationships between income and health (Gravelle 1998).
3. Multilevel-ordered logit analysis was also conducted using MIXOR (http://tigger.uic.edu/~hedeker/mix.html) to account for the skewed distribution of the depression scale. The results were consistent with those presented in Tables 2 and 3 except that the coefficient of Hispanic became nonsignificant in the ordered logit analysis.
4. The intraclass correlation was low because there was large individual-level variation within county, which represents both stable between-person differences (e.g., due to education) and all the transitory effects (e.g., temporary illness) as well as measurement errors. The county and individual-level variances were .13 and 3.85 in the fully unconditional model, and 0.04 and 3.11 in the model that included only individual-level variables. Since the intraclass correlation reflects both a numerator (county-level variance) and a denominator (county-level variance plus

individual-level variance), larger individual-level variation will lead to lower intraclass correlation for a given county-level variation.

5. Comparing the county-level residual variance of Model 1A (individual-level variables only) with Model 1B (Model 1A plus county-level mean income) indicated that mean income explained none of the variance; comparing the county-level residual variance of Model 1B and that of Model 1 indicated that income inequality reduced county-level variance by 27 percent. This variance-explained statistic from multilevel analysis provides the clearest evidence for making judgments about the importance of county-level predictors (Raudenbush and Bryk 2002).
6. Cross-level interaction between individual-level income and Gini was marginally significant (p-value < = .1), but it became nonsignificant once interaction between illness and Gini was included in the OLS regression models. It was not statistically significant in ordered logit analysis. None of the other SES and physical health variables had significant interaction with Gini in OLS or ordered logit analysis.

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